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The first machine consists of three elements: a Bendix G-15 computer, a large random-access slide projector, and an electric typewriter. The student sits in front of the typewriter and reads instructional items which are displayed by rear-view projection from 35mm slides in the random access projector. He then enters his multiple choice answer on the typewriter. Answers are recorded and evaluated in the computer. Feedback is supplied by a typewriter printout. The computer determines which slide to present next and selects that slide from the projector; then the cycle is repeated. The decision criteria governing slide selection are preprogramed by the person designing the lesson. The computer may be programed to select different slide sequences in response to a variety of student behavior.

Because of some limitations of the machine, a much enlarged facility called CLASS (computer-based laboratory for automated school systems) is being installed.

The control unit for the CLASS facility is a large Philco 2000 general-purpose digital computer. The classroom which is controlled by this machine contains 22 display units, 22 response devices, and monitoring equipment for the teacher. CLASS also has special rooms for simulating the counseling and administrative functions in a school. Central recording apparatus, one-way windows, and closed-circuit television provide for classroom observation. Each student has a display unit and a response device. The computer records and analyzes answers, and then determines what item the student should see next. The CLASS facility can be used as a group mode.

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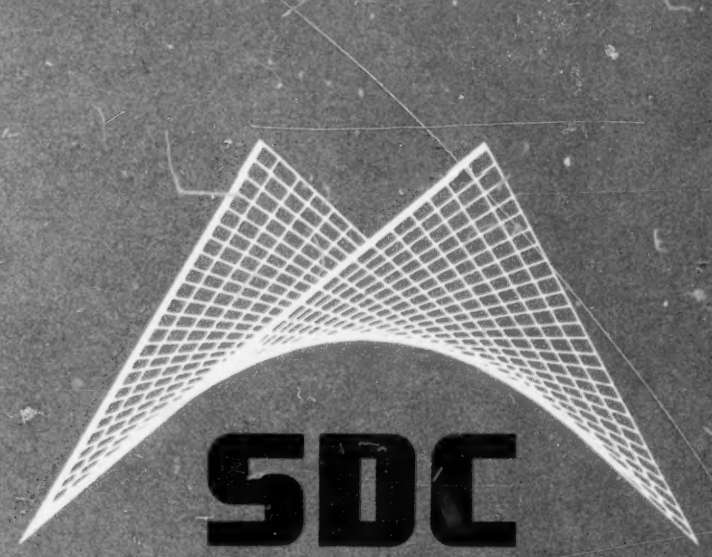

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Harry F. Silberman

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2 May 1961

SYSTEM DEVELOPMENT CORPORATION, SANTA MONICA, CALIFORNIA

Paper presented at the 1961 National Convention of the Department of Audio-Visual Instruction of the National Education Association, Miami, Florida, 25 April 1961.

The Computer Concept of Self-Instructional Devices

by

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Santa Monica, California

When Anna Hyer asked me to speak at this convention, it appeared as a fine opportunity to expand on some broad philosophical biases of mine. A brief inspection of the program showed that the broad perspectives were to be covered by the preceding speaker. One alternative to the general approach was to arrive at the convention with coat tails dipped in chalk dust, well armed with practical strategms on how to quiet a noisy classroom, repair a teaching machine, or thread a projector. Another quick glance at the program, however, revealed a list of attendees which included a sufficient number of field types to preclude such pretension. An intermediate approach might be called Weaver's law of maximizing the product of the familiarity of the object and the unfamiliarity of the object's name. With this law, one uses very unfamiliar words to describe very familiar things. The exercise of this law is often associated with a tendency to drift from the topic as exemplified by this introduction. Perhaps the wasted time is justified by the amount of time that has been saved by cancellation of an earlier plan to program this presentation in small step question-answer fashion.

The topic, the computer system concept will be developed in two ways: first, a description will be made of the small computer-based teaching machine which we are using as a research tool; second, a description will be made of the large computer laboratory for automated school systems which we are now developing.

The first machine consists of three elements: a Bendix G-15 computer, a large random-access slide projector, and an electric typewriter. The student sits in front of the typewriter and reads instructional items which are displayed by rear-view projection from 35-mm slides in the random-access projector. He then enters his multiple choice answer on the typewriter. Answers are recorded and evaluated in the computer. Feedback is supplied by a typewriter printout. The computer then determines which slide to present next. The computer then selects the next slide from the projector and the cycle is repeated.

The decision criteria governing slide selection are preprogrammed by the person designing the lesson. The computer may be programmed to select different slide sequences in response to a variety of student behavior. For example, if a student accumulates a prespecified number of errors on a set of diagnostic items he will be branched to specially designed remedial items. Or, if he takes too much time in responding to the items he may be branched to extra items. Or, he may indicate by pressing a key that he is having trouble and wants to review certain topics. If the student makes no errors, responds rapidly, and feels confident, items will be skipped permitting more rapid progress. A teaching machine with the sequence of instructional items tailored to the needs of the student is based on the notion that there is no single best item sequence. As research with this machine reveals dimensions of individual differences which interact with method and task variables, the machine can be programmed to treat students differently with respect to such dimensions. This tracking of the student's performance is expected to make a substantial contribution to student learning. We are now conducting research to determine what branching criteria are most effective. In an earlier experiment with the machine a comparison was made between a branching and a fixed sequence program in logic. No significant difference in learning was obtained between the two conditions. Faith in branching prevailed. The items were thoroughly revised with particular emphasis on improving the remedial material. A subsequent comparison yielded a significant difference in favor of the branching condition. Another research study provided support for the practice of writing many of our items in statement form. The usual procedure of giving the student immediate feedback after he answered a question, was not used. The student simply read the statement and went on to the next item. We are now developing a high school geometry program to study the relative effectiveness of different types of items on over- and under-achieving students.

One of the problems with our existing machine is that we can only run one student at a time. Futhermore, this machine does not permit the study of instructional methods within the broader classroom or school context. Consequently, we are now installing a much enlarged facility which we call CLASS. CLASS stands for computer-based laboratory for automated school systems. Some member of our project suggested restricting the title to automated school systems.

The control unit for the CLASS facility is a large Philco 2000 general-purpose digital computer. The classroom which is controlled by this machine contains 22 display units and 22 response devices and monitoring equipment for the teacher. CLASS also has special rooms for simulating the counseling and administrative functions in a school. Central recording apparatus, one-way windows, and closed-circuit television provide for classroom observation. Each student in the class has a display unit and a response device. The student typically reads an item on his film viewer

and then enters a multiple choice answer on his response device. Answers are recorded and evaluated in the computer, and feedback is supplied by small lights on the response device. The computer then determines what item the student should see next. The number of the next item is displayed on the student's response device. The student then turns to the indicated item on his film viewer and repeats the cycle. In this fashion each of 20 students in the class receives simultaneously individualized instruction from the computer.

The teacher has special monitoring equipment to keep track of what is going on in the classroom. When a student is having trouble an alarm light on the teacher's monitor console is activated. The teacher may defer action if she is busy or she may press a button on her console corresponding to that student's position and take a number of actions. For example, one action button will cause her response unit to be hooked in parallel with that student's response device. She may then observe his responses to each item. Another action button will call up further information about this student's performance on a flexowriter. This information will assist the teacher in diagnosing the source of the student's difficulty. A brief discussion with the student may help clear up his problem, and the incident will be recorded for future reference when the program is being revised.

The CLASS facility can also be used in a group mode. The teacher intersperses a group presentation with questions. The student response devices are used to answer the questions. Response data is instantly recorded, analyzed, and summarized by the computer. The teacher can modify the presentation during the lesson in accordance with this data.

After each lesson the computer analyzes the data that it has recorded. These analyses are used to improve the instructional material and its method of presentation.

With the CLASS facility we can go beyond a piecemeal study of self-instructional methods. For instance, we know that allowing students to move at their own rate greatly increases their heterogeneity with respect to grade placement. This results in a more frequent regrouping or rescheduling problem. How can we solve such a problem when the complexity of school scheduling has already restricted flexibility in period length, class size, and even teaching procedures. Fortunately computer programs exist which will perform complex scheduling. But a more complex schedule will complicate the many administrative decisions which must be made. Where will administrators be trained in making such decisions? School boards generally take a dim view of their schools being used as a training ground in administrative decision-making. Again CLASS comes to the rescue. Computers have been used very effectively in simulating battle

conditions for training military commanders. With the CLASS facility it is possible to produce a variety of realistic problems which the administrator might have to face. These situations are presented to the administrator who must then make decisions. He is given feedback on the consequences of these decisions and gradually learns to estimate the probability of various consequences contingent on his actions. In the course of one training session, the administrator may experience the consequences of decisions which would have normally taken a full year. The point I've been trying to make here is that, the CLASS facility allows us to consider the school system as a whole in analyzing the interaction among the various components within the system.

Of course we are also concerned with the instructional questions. In presenting instructional items for example, branching is supposed to adapt the sequence of material to the needs of the individual student. The goal is to minimize his errors as well as the time required for him to complete the lesson. The question is how to do this without sacrificing the extent to which the learning will generalize to novel problem situations. Another question is how to use a computer in the assembly of long sequences of items. The task of organizing a sequence of items for a four-year high school program is enormous. Given a suitable classification scheme for items, the computer would be an indispensable aid for assembling an integrated sequence of thousands of items. The computer can insure that these items have both longitudinal and cross-sectional continuity.

Finally, looking into the future, we may expect to see automated school systems which use modern technological methods already being implemented in the industrial world. Exciting new research with computers that learn, retrieve information, translate languages, recognize printed symbols, and solve difficult logical problems may have a major impact on automated education of tomorrow. We may choose to view the teaching machine as simply another self-instructional aid to be added to the teacher's arsenal. Or, we may view it as a vital link between education and modern technology.